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L system strategy: the associated growth of a characteristic type of multicellular development

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A typical mode of development is frequently observed at all levels of organization in the lower and higher plants: a zone of undifferentiated cells with great mitotic activity and generating a zone of differentiated cells which have lost all ability to divide. A question is put: does this type of development imply, by its very nature, a specific form of growth curve for organisms, organs, or parts of organs, which exhibit this development? To answer a question formulated in such a general manner causes difficulties of a biological nature, so it is proposed to represent simply this type of development in a one-dimensional array of cells by a primitive model assumed to summarize the root of the developmental mode. The model, consisting of a class of L systems, enables a specific form of growth curve to be found and suggests a connection between a frequently occurring type of development and a form of growth curve often encountered (growth by successive ' platforms '). The value of the strategy used is to show that very simple mechanisms may exist which can, by themselves, explain some phenomena (in particular, periodic phenomena) observed at a high level of organization.

1. Introduction

Lindenmayer systems, or L systems, which are today one of the most widely investigated areas of formal language theory, were introduced by Lindemayer (1968) as a model for the developmental growth in filamentous organisms. A one-dimensional array of cells, defining the organism at a given moment, is symbolized by a sequence of letters (or filament). The letter which is assigned to each cell is regarded as a discrete cellular state at this moment; each cell may be in one of a finite number of states (distinct letters).

> " The justification for assuming a finite set of states is that there are usually threshold values for parameters that determine the behaviour of a cell. Thus, with respect to each of these parameters, it is sufficient to specify two conditions of the cell: ' below threshold ' and ' above threshold ', although the parameter itself may have infinitely many values" (after Herman).

An L system consists of a finite set of letters (alphabet), of a set of rewriting rules (productions), of an initial sequence of letters (axiom) and of an environmental letter corresponding to the influence of the environment. The axiom, or starting filament, symbolizes the organism at an arbitrary moment of origin; time is assumed to progress in discrete steps. The subsequent stages of development of the initial filament are symbolized by consecutive sequences of letters which are obtained, starting from the origin time, by rewriting all the letters of a sequence, simultaneously at each time step. Rewriting rules take into account cell division, since any single letter may be rewritten as two letters. When the

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